GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering (Mechanical, Energy Engineering)
Subject Code: 3733906
Semester – III
Subject Name: Solar Architecture

Type of course: Program elective

Prerequisite: Knowledge of solar energy, Solar photovoltaic system and cooling system.

Rationale: The course intends to provide knowledge of utilization of solar energy for the architecture to graduate students.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	0	0	100

Content:

Sr. No.	Content	Total Hrs
1	**Heating, cooling and lighting as form-givers in architecture:** Indigenous and vernacular architecture, Sustainable design approach, Dynamic versus static building, colour, energy and climate for architecture. **Sustainable design and energy sources:** Sustainable design and issues, Reuse, Recycle, and Regenerate by design, Sustainable movement, Supply versus efficiency, Climate change, Global greenhouse, Ozone hole. **Climate:** Climate anomalies, Relative Heating and Cooling loads, Climate information.	**5**
2	**Thermal Comfort:** Thermal Barriers, metabolic rate, Thermal conditions of environment, Heat content of air, Sifting of comfort zone, Adaptive comfort, Clothing and comfort, Strategies. **Passive Solar:** Latest discovery in passive solar, Direct-gain system and design guideline, Trombe wall system and design guidelines, Design guideline for sunspace, Heat storage material, comparison of main passive system. **Passive Cooling:** Introduction, Passive cooling system, Ventilation versus night-flush cooling and its design, Basic principle of airflow, airflow through building, Operable roofs, Radiant and evaporative cooling, Cool towers, Earth cooling, Dehumidification and desiccant, Solar Chimney.	**7**
3	**Photovoltaic and Active Solar:** Introduction of PV, Types of PV system, Balance of system equipment, Building –Integrated PV, Roof clad and Facades Clad with PV, Orientation and tilt, glazing and PV, PV shading devices, Sizing of PV for standalone building, Design guideline, Active solar system – solar swimming pool, solar hot water, solar air collector, Design of active solar system.	**6**
4	**Lighting:** Introduction, Reflectance/Transmittance, Colour, Vision, Perception, Illumination level and Brightness ratio, Rules for lighting Design **Day Lighting:** Why day lighting, Conceptual Model, Light without Heat, Basic day lighting strategies, Basic and advanced window day lighting strategies, window glazing	**7**

	materials, Top lighting, Sky light strategies, Day lighting Techniques and guidelines, Translucent walls and roofs, Physical modeling. **Electrical Lighting:** Introduction, As a supplement, Types of lamps, Remote-source lighting system, Solid state, Architectural, Outdoor and Emergency lighting and its control, Rules for energy efficient lighting design, Laws and Standards.	
5	**Shading and Colour:** Introduction, Fixed exterior and movable shading devices, Overhangs and its design, Shading design for south wall, east and west wall, Design guideline for fixed and movable south, east and west overhangs, Design of fins on north windows, Design guideline for eggcrate shading devices, Shading strategies, Shading interior and outdoor spaces and devices, Glazing as shading devices, Solar heat gain coefficient, Roof and wall reflectivity, Physical models for shading.	**6**
6	**Site Design, Community Planning and Landscaping:** Introduction, Site selection, Solar access, Site planning, Physical models, Wind and site design, Plants and vegetation, Vegetated roofs, Lawns and landscaping, Community design.	**5**
7	**The Thermal Envelope: Keeping Warm and Staying cool:** Introduction, Heat loss and gain, Solar reflectivity, Compactness, exposed area and thermal planning, insulating materials, Thermal envelope, Heat bridges, Windows, Movable insulation, Earth Sheltering, Infiltration and Ventilation, Moisture control, radon appliances. **Mechanical Equipment for Heating and Cooling:** Introduction, Thermal Zones, Heating systems, Cooling systems, Air-conditioning for small and large buildings, Design guidelines for mechanical systems, Air supply, Ventilations, Air filtration and odor removal.	**6**

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**20**	**20**	**20**	**20**	**10**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1) Heating, Cooling Lighting- Sustainable Design Methods for Architects, Norbert Lenchner, Wiley.
2) Solar Passive Building, Science and Design, M.S. Sodha, N.K. Bansal, P.K. Bansal, A. Kumar, and M.A.S.Malik, Pergamon Press.
3) Passive Solar Architecture: Heating, Cooling, Ventilation, Day lighting and More Using Natural Flows, David Bainbridge, Ken Haggard, Chelsea Green Publishing,
4) In detail: architecture solar: strategies, visions, concepts, Christian Schittich, Birkhauser Edition Detail.
5) Passive Solar Architecture Pocket Reference (Energy Pocket Reference), Ken Haggard, David A. Bainbridge, Rachel Aljilani, Earthscan from routledge.
6) The Solar House: Passive Heating and Cooling, Daniel D. Chiras, ChelseaGreen Publishing Company.

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Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To appraise sustainable design requirements for the solar architecture and design guideline of passive solar and passive cooling system for the solar architecture.	35%
CO-2	To appraise requirement of the Solar PV system for solar architecture.	10%
CO-3	To apply the lightning system for the solar architecture and to select and apply design guideline for the shading and color for the solar architecture.	30%
CO-4	To comprehend the guideline for the site selection and planning for the solar architecture.	10%
CO-5	To understand the concepts of thermal comforts and related mechanical devices for the solar architecture.	15%

List of Experiments:

1) To study the concept of heating, cooling and lighting in Architecture.
2) To study the sustainable design and energy sources for the solar architecture.
3) To study the passive solar systems and passive solar cooling design for solar architecture.
4) To study the photovoltaic and active solar systems for solar architecture.
5) To study the concept of shading and colours for solar architecture.
6) To study the concept of day lighting systems for solar architecture.
7) To study the concept of electrical lighting systems for solar architecture.
8) To study the mechanical systems for heating and cooling for solar architecture.
9) To study the site design, community planning and landscaping for solar architecture.
10) To study the checklist for designing integrated sustainable building for solar architecture.

Major Equipment: Models of solar architectures, mechanical systems for heating and cooling for solar architecture

List of Open Source Software/learning website:

1) http://ocw.mit.edu/courses/energy-courses/